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short review

Advances in Nanoscience and Nanotechnology

Nanoscience in the k-12 classroom: More Needed than Ever

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Abstract

The topic of nanoscience and nanotechnology has gained popularity in the last decade with the widespread of its various applications to daily used products and services. This has led to an increased interest by the public to learn more about this unique and small world. However, there is still a significant lack in comprehensively defining the field of nanoscience and understanding its fundamental laws that govern the behavior of particles at the very small nanoscale. It has been noticed from several in-person as well as virtual interactions with educators in the sciences that there is an increased interest in inquiring more about the field and how it is impacting our lives with its ongoing advancements to various aspects of our lives. This was more prominent during the coronavirus disease 2019 (COVID-19) pandemic season as nanoscience and nanotechnology have taken a central role in understanding the disease progression, providing early detection tools as well their significant involvement in vaccine development. I have taken a role in multiple initiatives to illuminate on the involvement of nanotechnology in combating the COVID-19 pandemic and have concluded that there is greater need than ever to integrate the subject matter to the k-12 classroom and educate our future generations on this incredible unique Nano world. Here we will review the need to introduce the fundamental knowledge of nanotechnology into the education curriculum, while emphasizing on its usefulness in fighting infectious diseases such as the SARS-CoV-2 virus.

Keywords: Nanotechnology, Nanoscience, Nano education, K-12 Classroom, COVID-19 Vaccine, SARS-CoV-2 Virus

Main

The fields of nanoscience and nanotechnology have contributed to improving many areas of our lives and are continuing to provide solutions to various problems in the world. Both fields have driven research labs from all over the world to inquire, examine, manipulate and mimic the behavior of particles at the nanoscale. These nanoparticles that can be a diameter of about 1/1000th of a single human hair and that we commonly encounter daily, such as proteins in our bodies, viruses, human DNA and even down to the single units of matter the single atom, have unique physical properties that are quite different from macromolecules. The research conducted in both areas aims at first to accurately understand the behavior of these nanoparticles by studying their unique physical and chemical properties from the lens of quantum mechanics for potential applications in medicine, material science, information technology, environmental science and many more. Some of the daily products that we currently use are either made of nanoscale materials or rely on nanoscale processes. Yet very little is known about these fields by the public. It appears that there is a high percentage of the public who is unaware of the nanoscale, its fundamental laws and potential applications. Hence, the need to include a fundamental course or chapter in introductory science courses to introduce the fields of nanoscience and nanotechnology to students in the k-12 classroom.

Past and Current Initiatives

Multiple initiatives have been implemented in the past to educate students on nanotechnology using various modalities such as presenting key concepts to high school students. The program implemented key concepts in nanotechnology in a one-unit course and have found that there was a shift in students' conception after learning these fundamental concepts [1]. The National Nanotechnology Initiative has done tremendous work in various projects aimed at developing and providing nanoscience and nanotechnology resources for educations in the k-12 classroom. One example is the High School Nanoscience Program that brings fundamental learning resources of nanoscience to the high school classroom in the Los Angeles Unified School District and the greater Los Angeles area. This program is a joint initiative between the California Nano Systems Institute and the NSF-funded IGERT Materials Creation Training Program [2]. Additional resources are always available at Try Nano, which is a website full of learning materials

on nanoscience and nanotechnology tailored specifically for high school students and teachers [2].

At the higher education level, a course has been developed for a summer session at the University of California Los Angeles in nanoscience, where students are provided the opportunity to explore basic applications in the field through reviewing scientific literature and applying what they have learned to their own unique ideas that they can bring to the market. The program is a two-week accelerated program with an extensive learning experience both in scientific methodologies at the nanoscale as well as in extending the concepts to real-world engineering and business projects [3]. This is a very short list of implementation initiatives of nanoscience and nanotechnology in early education. There is an increased need for continuing to provide information and basic knowledge of both fields and their interdisciplinary nature to the public and this cannot be done in a more effective strategy than integrating it into the k-12 science curriculum.

Rapid Translation of Nano Research from bench to people: Greater Need for Nano Education

The efforts that have been employed to illuminate on the fields of nanoscience and nanotechnology have been excellent in providing the resources needed for teachers to bring the concepts into the classroom. However, there is still a significant lack of knowledge in both fields in the public that could be alarming especially in times like today when nanomaterials are used daily and are involved in major part of our lives. This alarming call was more prominent during the pandemic season of COVID-19. The public was and still is in a state of fear of the unknown accompanied by the rapidly and life-threatening virus. The community lacked a consistent channeling of information regarding the viral infections, disease progression and specifics related to regulatory actions. This can be related to nature of this virus as it has been a learning experience for scientists, medical professionals as well as NIH and other governmental agencies' all over the world, since the start of the pandemic.

However, nanoscience and nanotechnology were both taking the spotlight in their contributions to reliable virus detection tests, understanding of viral progression as well as vaccine development. This interdisciplinary field has pulled together major disciplinary concepts from the sciences at the nanoscale to accurately describe disease progression inside the human cell, while providing insight on ways to halt its rapid replication in the body [4]. And one might wonder why a Nano lens is needed to understand a highly transmissible virus such as the SARS-CoV-2 virus. Well, as Kostarelos would communicate to many of his students during his teaching of Nano medicine "Remember, viruses are the most beautiful, smart and capable nanoparticles!" [5].

In response to this devastating and challenging season, the interdisciplinary forces of nanotechnology and nanoscience were all aimed at combatting the COVID-19 pandemic and both fields have been involved in the fight against other numerous infectious diseases due to their ability to detect with ultra-sensitivity and provide dose-regulated targeted therapies for various infections, such as Malaria and Tuberculosis [6]. In the next section of this article, some of the various contributions of both fields to the fight against COVID-19 will be presented.

Nanotechnology Approaches COVID-19 from Various Angles

The outbreak caused by the COVID-19 virus has worsened rapidly since the start of the pandemic due to its smart ability to mutate at a rapid rate and develop stronger resilience and resistance. The ability to decode and share the genome sequences can aid in controlling its rapid transmissibility; hence, slowing down the outbreak and providing professionals with more insight on disease progression. In this attempt, a group of researchers utilized an Oxford Nano pore Technologies (ONT) Minion sequencing technology to provide coding complete sequences of the virus from positive samples in one day [7]. That's an impressive accomplishment for real-time technologies and their contributions to the outbreak.

Nano traps were designed by the Huang Lab, to capture the SARS-CoV-2 virus and clear it from the body. The Nano traps are functionalized with antibodies against the SARS-CoV-2 virus to capture the virus and are engineered to mimic the human body's immunity in macrophage cells to engulf and clear the COVID-19 virus [8]. The SARS-CoV-2 virus was found to range from 60 to 140 nm including its surface morphology, which makes it a target for novel nanostructures that can uptake it in the body. Furthermore, Nanotechnology has made a major impact in introducing various point-of-use rapid and reliable detection tools for the COVID-19 virus [9]. These rapid tests are cost-effective and simple diagnostic tools for point-of-care use. One example employs metal nanoparticles that have been functionalized with specific antibodies and attached on a paper-like membrane strip. The lateral flow viral particles will pass through a chamber that contains this membrane strip and if virus-specific antibodies are present, a positive linkage will occur with the surface, leading to a positive signal output in real-time detection. This was made possible by metal nanoparticles that possess unique optical and fluorescence activity or even color change ability responsible for the signal [9].

Finally, COVID-19 first vaccines made available to the public have been developed utilizing Nano biomaterials that are characterized by their effective and stable routes of delivery of vaccine material as well as their reduced toxicity for the human body. The first two vaccines that were introduced to the public, relied on lipid nanoparticles that encapsulated the SARS-CoV-2 spike protein mRNA. This effective route makes vaccines safe and controlled as they enter our human body [10].

Concluding Remarks

These diverse Nano technological interventions have presented a promising approach to tackle some of the most challenging needs in the fight against the COVID-19 pandemic. This field that is highly interdisciplinary can be introduced to our younger generations; to educate them on the various advancements and contributions it is transferring to world-wide applications. This information should not only be an exchange topic within the scientific community; however, should be a source of peace and comfort to the general public as the pandemic has left the world in a state of fear. Through my recent presentations on nanotechnology and vaccine development, I sensed a state of surprise of how much Nano research has

contributed to the fight against COVID-19 pandemic. It has also provided them with hope to know that there is a uniquely small world behind the great advancements introduced to improving our daily lives.

In concluding remarks, educating our young generations on the fundamentals and applications of nanoscience and nanotechnology has never been a greater need than today especially, when every human being around the globe has been impacted by a pandemic that can be ended by the joined forces of nanoscience and nanotechnology. This suggestion entails including both topics as core subjects in k-12 science curriculum across the nation.

Reference

1. Pelleg B, Figueroa M, VanKouwenberg M, Fontecchio A, Fromm E (2011) Implementing Nanotechnology Education In The High School Classroom. In 2011 Frontiers in Education Conference 2011: F4D-1.
2. NNI (2021) Educational Resources for K-12 Teachers. National Nanotechnology Initiative : https://www.nano.gov/education-training/teacher-resources
3. UCLA (2021) UCLA Summer Sessions. Application of Nanoscience Summer Institute: https://www.summer.ucla.edu/institutes/ApplicationsofNanoscience
4. Sivasankarapilai VS, Madaswamy SL, Dhanusuraman R (2021) Role of Nanotechnology in Facing Sars-Cov-2 Pandemic: Solving Crux of The Matter With A Hopeful Arrow in The Quiver. Sensors International 100096.
5. Kostarelos K (2020) Nanoscale Nights of COVID-19. Nature Publishing Group 2020: 343-344.
6. Kirtane AR, Verma M, Karandikar P, Furin J, Langer R, ET AL. (2021) Nanotechnology Approaches For Global Infectious Diseases. Nature Nanotechnology 16: 369-384.
7. Jenjaroenpun P, Wanchai V, Ono Moore KD, Laudadio J, James LP, ET AL. (2020) Two SARS-CoV-2 genome sequences of isolates from rural us patients harboring the D614G Mutation, Obtained Using Nanopore Sequencing. Microbiology Resource Announcements 10: e01109-20.
8. Abbasi J (2021) Nanotraps Designed to Capture and Clear SARS-CoV-2. JAMA 325: 2243-2243.
9. Rabiee N, Bagherzadeh M, Ghasemi A, Zare H, Ahmadi S, et al. (2020) Point-Of-Use Rapid Detection Of Sars-Cov-2: Nanotechnology-Enabled Solutions For The Covid-19 Pandemic. International journal of molecular sciences 21: 5126.
10. Yayehrad AT, Siraj EA, Wondie GB, Alemie AA, Derseh MT, et al. (2021) Could Nanotechnology Help to End the Fight Against COVID-19? Review of Current Findings, Challenges and Future Perspectives. International Journal of Nanomedicine 16: 5713., 5713-1743.